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(71)Applicant : MINOLTA CO LTD

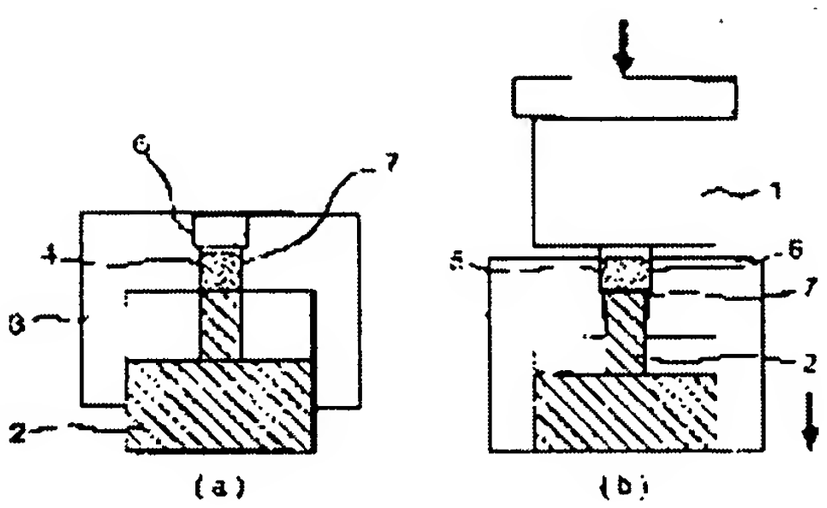
(72)Inventor : TOMISAKA TOSHIYA

(54) METHOD OF FORMING LENS THICK IN CORE THICKNESS

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a forming method which is excellent in the die transferability of a lens thick in core thickness combined with a droplet process.

SOLUTION: The method of molding the lens thick in core thickness is a method of forming the lens by dropping a molten glass droplet to bisected dies consisting of a lower die and an upper die, then lowering the upper die to press forming the lens and is set higher in the temperature of a master mold than the temperature of the lower die, in which the master mold is removed and the lens is formed by the upper die and the lower die at the point of the time the dropped glass droplet is cooled down to the state that the droplet does not flow by gravity any more. The method of forming the above lens comprises dropping the glass droplet in the state of using the master mold smaller in the diameter than the intrinsic master mold and replacing the master mold with the intrinsic outer mold at the point of the time the dropped glass droplet is cooled down to the state that the droplet does not flow by gravity any more, then lowering the upper die and forming the lens.



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the shaping approach of the thick lens of heart thickness, especially the shaping approach of the thick lens of the heart thickness combined with the sessile drop method.
[0002]
[Description of the Prior Art] As a manufacturing method of a lens, the sessile drop method which trickles melting glass by natural dropping from a small hole is developed. This approach is an approach which was excellent when manufacturing a minute lens efficiently simply. Although the thickness of a lens was decided by this sessile drop method mainly with the viscosity of the melting glass at the time of shaping, it was difficult to make melt viscosity low for drop formation, therefore to fabricate a thick lens by the sessile drop method itself generally.
[0003] Generally it needed to depend on applying the above-mentioned sessile drop method and fabricating the thick lens of heart thickness at press forming using a dies body. However, in order that the fused glass may receive cooling from a mold, temperature spots tend [very] to produce only the interior of a glass drop, the exterior, and the exterior by the part. As for a glass drop, a side face becomes hard earlier by cooling from the dies body which forms especially the side face of a lens. Therefore, since the welding pressure of the vertical direction was not transmitted all over the vertical side of glass in compression moulding technique with the conventional mold, it was difficult for the imprint nature of a mold to fabricate the thick lens of heart thickness it is bad and homogeneous and good. Moreover, when pressurizing by force, there was also a problem that the edge of glass was damaged. On the other hand, the 2-minute sprit mold which divided a dies body and female mold is known as such a molding die. However, even if it used such metal mold, the phenomenon in which, as for the drop in metal mold, the side face was first cooled by the dies body was not avoided, but the same problem generated it.
[0004] Recently, miniaturization of an optical instrument progressed and optical system with a short focal distance was used more often with the single lens. In order to give big power to a single lens and to suppress aberration, the thick lens of heart thickness is desirable to an outer diameter. In order to meet such want, the further new ED is called for.
[0005]
[Problem(s) to be Solved by the Invention] This invention offers the shaping approach excellent in the mold imprint nature of the thick lens of the heart thickness combined with the sessile drop method.
[0006]
[Means for Solving the Problem] This invention offers the technique for fabricating the lens with which heart thickness imprinted the configuration of metal mold good thickly, and includes the following techniques. Namely, a lens is set to the shaping approach of the lens which carries out pressing by a punch raising descent or female mold, after a melting glass drop is dropped on the female mold of the 2-minute sprit mold which consists of a dies body for regulating female mold and female mold, and the divided side face by the 1st approach of this invention. It is related with the shaping approach of the thick lens of the heart thickness characterized by setting up the temperature of a dies body more highly than the temperature of female mold.
[0007] Moreover, a lens is set to the shaping approach of the lens which carries out pressing by a punch raising descent or female mold, after a melting glass drop is dropped on the female mold of the 2-minute sprit mold which consists of a dies body for regulating female mold and female mold, and the divided side face by the 2nd approach of this invention. When the dropped glass drop cools in the condition of not carrying out natural floating any longer, a dies body is removed substantially, and it is related with the shaping approach of the thick lens of the heart thickness characterized by carrying out pressing of the lens between a punch and female mold.
[0008] Furthermore, a lens is set to the shaping approach of the lens which carries out pressing by a punch raising

descent or female mold, after a melting glass drop is dropped on the female mold of the 2-minute sprit mold which consists of a dies body for regulating female mold and female mold, and the divided side face by the 3rd approach of this invention. A glass drop is dropped where a dies body with a path smaller than an original dies body is used. When the dropped glass drop cools in the condition of not carrying out natural floating any longer, a dies body is changed to an original dies body, and it is related with the shaping approach of the thick lens of the heart thickness characterized by going up descent or female mold in a punch subsequently, and fabricating a lens.

[0009] Although the thick lens of the heart thickness of various magnitude can be fabricated in above-mentioned this invention, it is suitable for shaping of the thick microlens of especially heart thickness. Especially as for a microlens, a diameter says a lens 2.0mm or less 6.0mm or less here. Moreover, the thick lens of the heart thickness as used in the field of this invention means the thing of the lens which has the following relation, when heart thickness is set to t and an outer diameter is set to d. t>=(1/2) d [0010] Each approach of this invention uses the 2-minute sprit mold which consists of a dies body for regulating female mold and female mold, and the divided side face, and after it trickles a melting glass drop on the female mold, it becomes amelioration of the shaping approach of the lens which carries out pressing of the lens by a punch raising descent or female mold. Female mold and a dies body are divided and a 2-minute sprit mold is the shaping metal mold of the type which can operate independently here.

[0011] Moreover, dropping of a melting glass drop can make a melting glass drop able to collide on the member which prepared penetration pore, and can be formed by the approach of extruding at the rear face of penetration pore by making a part of the glass drop into a minute drop as indicated to the application for patent 2001-263763. Thus, a melting glass minute drop with a diameter of 5mm or less can be dropped at female mold, for example. One example of the formation approach of a melting glass drop was shown in drawing 4 .

[0012] In the 1st approach, i.e., the method of setting up the temperature of a dies body more highly than the temperature of female mold When it is cooled to the viscosity range suitable for shaping and the whole glass drop performs pressing Since it has not resulted in hardness to the extent that fabricating becomes difficult [the part which touches the dies body of a glass drop], pressing by the punch is performed reasonable, and shaping of a good lens is attained, without producing lowering of mold imprint nature, and generating of distortion. Even if it doubles descent of a punch, and lifting of female mold and performs them at the last application-of-pressure process besides descent of a punch performing, all are within the limits of this invention satisfactory natural. The temperature requirement of a dies body is set as a desirable temperature requirement higher 30-150 degrees C than female mold temperature and a more desirable temperature requirement higher 50-80 degrees C than female mold temperature that what is necessary is just more highly than the temperature of female mold. The making machine style of the 1st approach was shown in drawing 1 .

[0013] When it cools in the condition of not carrying out natural floating any longer, the 2nd approach, i.e., dropped glass drop, a dies body is removed substantially, and in the shaping approach which fabricates a lens between a punch and female mold, pressing is performed in the condition that a dies body does not exist substantially. It may mean that there should just be even the condition that it is not in contact with a glass drop even if a dies body exists as the condition of not existing substantially, for example, a dies body may be moved up and down, and you may realize by extending outside. While a glass drop has a natural fluidity in this approach and the important problem needs to secure the thickness of a drop as a dies body is made to exist and a glass drop does not spread, it is removing a dies body promptly, when not carrying out natural floating, and starting the application of pressure by the punch and female mold. Since thickness can be held and the dies body is removed even if regulation by the dies body is removed, in order not to carry out natural floating of the glass, cooling of the glass side face by the dies body in an application-of-pressure process will be prevented, there will be no pressure transfer inhibition of the vertical side of glass, and it will excel in the mold imprint nature by the punch and female mold.

[0014] The method of removing a dies body may be what kind of approach, for example, is simple for the outside surface of female mold to meet, to slide a dies body, and to move caudad from female mold. Moreover, also in this approach, you may also incorporate the approach of making dies body temperature higher than female mold as well as the 1st approach. The making machine style of the 2nd approach was shown in drawing 2 .

[0015] A glass drop is dropped where the 3rd approach, i.e., a dies body with a path smaller than an original dies body, is used. In the approach of changing a dies body to the dies body of an original path, when the dropped glass drop cools in the condition of not carrying out natural floating any longer, and going up descent or female mold in a punch subsequently, and fabricating a lens Unlike the 2nd approach, at the time of the application of pressure by the punch and female mold, the description is in the place performed under existence of a dies body. Since a dies body exists, a periphery is regulated, therefore the heart picking process from a Plastic solid becomes unnecessary. Conversion of the path of the dies body in this approach For example, the dies body with which the part 6 which has an original bore, and

the part 7 which has a path smaller than it were connected up and down as shown in drawing 3 , When the glass drop dropped at the part which has a small path cools in the condition of not carrying out natural floating any longer, using the female mold which slides along with the small path, the approach of lowering a dies body, or pushing up female mold, and fabricating a glass drop using the dies body part which has an original bore is convenient. The making machine style of the 3rd approach was shown in drawing 3 .

[0016] Hereafter, the shaping approach of this invention is explained using drawing. The shaping approach of the thick lens of the heart thickness by the 1st invention was typically shown in drawing 1. In this invention, the melting glass drop 4 is dropped on female mold 2 and the female mold 2 of the shaping space surrounded by the dies body 3, and a glass drop is annealed here until it becomes the suitable temperature for the pressing by the punch (drawing 1 (a)). With the conventional technique, although especially the temperature of female mold and a dies body was not taken into consideration, the description of this invention is in the place by which the dies body is controlled by temperature a little higher than female mold. Therefore, when it goes, most of the temperature requirement for pressing where temperature is suitable, i.e., the viscosity range, of a glass drop, the part which touches the side face of a glass drop, i.e., a dies body, does not yet result in solidification, either, but has deformability. Therefore, even if it descends a punch 1 at this event and performs pressing between female mold and a dies body (drawing 1 (b)), ** is transmitted to homogeneity, and the glass drop whole [5] can deform plastically smoothly, and can acquire a Plastic solid faithful to metal mold, i.e., the good Plastic solid of mold imprint nature.

[0017] The shaping approach of the thick lens of the heart thickness by the 2nd invention was typically shown in drawing 2. In this invention, when it arrives at the suitable temperature requirement for pressing without the temperature of the melting glass drop 4 (drawing 2 (a)) currently annealed between female mold 2 and a dies body 3 already carrying out natural floating and, a dies body 3 is moved to the place which does not touch a glass drop. For example, in the case of drawing 2 (b), a dies body is moved below along with female mold. A punch 1 descends in this condition and pressing is performed between female mold 2. The lens reproducing a form faithful to the configuration determined between a punch and female mold is fabricated without preventing the further cooling of the lateral portion of a glass drop, and blocking smooth plastic deformation, since a dies body does not exist in a side face in pressing.

[0018] The shaping approach of the thick lens of the heart thickness by the 3rd invention was typically shown in drawing 3. In this invention, what has two steps of bores as a dies body is used. In the example of drawing 3, the part 6 of the bore of the normal by which a dies body is used at the time of shaping, and the part 7 of a bore smaller than it are continuing up and down. The dropped melting glass drop is held on female mold in a bore part with a small dies body, as shown in drawing 3 (a), and it is annealed here. When the temperature of the melting glass drop 4 arrives at the suitable temperature requirement for pressing, female mold is raised, or a dies body is dropped, and the glass drop 4 (5) is moved to the part 6 which has the bore of the normal of a dies body. Drawing 3 which descends a punch 1 in this condition and carries out pressing of the glass drop 5 between female mold (b). Although a glass drop deforms plastically by application of pressure, in early stages of application of pressure, since it is not in contact with a dies body, solidification of a glass drop side face cannot arise, but a glass drop can transmit ** from the upper and lower sides to the whole glass. A glass drop spreads in a longitudinal direction with progress of application of pressure, a dies body is reached soon, and a glass drop is fabricated by the configuration regulated by the bore part 6 of the normal of a punch 1, female mold 2, and a dies body. In this way, since the whole is fabricated according to the configuration of metal mold, the acquired lens Plastic solid has the unnecessary heart picking process after taking out from a mold.

[0019] In addition, also in invention [which], as shown in drawing 4 as a mimetic diagram, the melting glass drop dropped on female mold makes the melting glass drop 9 collide on the above-mentioned member 10 which formed the penetration pore 11, from the opposite hand (below) of a member, is beginning to pass the part as a drop 20, and is formed.

[0020] By the approach of this invention, if the glass drop to be used is glass for optics, in [any] glass, it can apply.

[0021]

[Example] Hereafter, an example explains this invention in detail and concretely.

The glass drop with a temperature [of 1050 degrees C] and a weight of 120mg dropped by the equipment of drawing 4 was dropped using the metal mold which consists of a vertical mold with which the thickness for a core part of the lens decided by spacing of example 1 outer diameter of 4.0mm, a punch, and female mold is set to 3.6mm into the shaping space surrounded with a dies body and female mold as shown in drawing 1. Temperature control of a dies body and the female mold is carried out independently, and they were held at 590 degrees C and 480 degrees C, respectively. The punch was dropped after [after dropping a glass drop] 2.8 seconds, and pressing was performed. After about 8 seconds. since the glass drop carried out cooling solidification enough, it was taken out from the mold. It was checked that the profile irregularity which the outer diameter of 4.0mm and heart thickness are 3.2mm, and measured the obtained lens

with the reflected wave side interferometer is better than lambda/4. In addition, lambda is the wavelength of the laser beam used with the interferometer.

[0022] In example 2 example 1, instead of pressurizing by descent of a punch, female mold was also raised, and it pressurized and fabricated from both upper and lower sides with descent of a punch. Profile irregularity is lambda/6 and profile irregularity of configuration precision of the obtained lens was improving further. The heart picking process according to post processing by improvement in profile irregularity was unnecessary.

[0023] The melting glass drop was dropped using the metal mold configuration shown in example 3 drawing 2 on the female mold in the shaping space surrounded with a dies body and female mold on the same conditions as an example 1 After [of dropping] 2 seconds, the inner surface dropped the dies body, making the outside surface of female mold meet, and contact to a glass drop and a dies body was severed. Immediately after descending the dies body, the punch was descended, and pressing of the lens was carried out between a punch and female mold. Since there was no periphery regulation by the dies body at the time of shaping, the profile irregularity of the obtained lens was as high as lambda/6, and was the outer diameter of 4.2mm, and heart thickness 3.1.

[0024] The thing with two kinds of bores for the narrow diameter portion connected with a part for the topmost major diameter (bore of 4.0mm) immediately in the bottom of it as example 4 dies body as illustrated to drawing 3 (bore of 3.1mm) was used. Female mold and a dies body slid on the outer diameter of female mold as 3.0mm. The temperature of a dies body and female mold was 540 degrees C and 500 degrees C, respectively. In the condition of having fitted in with a part for the narrow diameter portion of a dies body, the topmost part of female mold trickled the glass drop with a temperature [of 1050 degrees C], and a weight of 120mg on female mold with the equipment of drawing 4 like the example 1. A dies body is driven below and it was made for the location of a glass drop to come to a part for the major diameter of a dies body after [of dropping] 1.6 seconds. The punch with an outer diameter of 3.0mm was descended in this condition, and the large lens of heart thickness was fabricated. The profile irregularity of the obtained lens was excellent with lambda/6, and was unnecessary by the external regulation by the dies body. [of the heart picking tail end process of the outer diameter of 4.0mm and 3.0mm of heart thickness]

[0025] The lens was fabricated like the example 1 except having held at both 500 degrees C, without controlling independently the temperature of example of comparison 1 dies body, and female mold. Although the dropping [of a glass drop], 2-second, and 4-second back was chosen at the application-of-pressure event by the drop of a punch, also when it was any, a fault like a periphery crack generated profile irregularity in lambda extent.

[0026]

[Effect of the Invention] By the sessile drop method and the shaping approach of this invention which uses 2 division configuration metal mold, it excelled in field imprint nature, and it can be minute and the thick lens of heart thickness can be fabricated now. Especially by the approach incorporating outside diameter calibration, the process became unnecessary after heart picking needed by the old approach, and the production process was also rationalized.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The mimetic diagram showing the shaping approach of the thick lens of the heart thickness by the 1st invention
(a) The cooling phase of the melting glass drop on female mold
(b) The press-forming phase by the punch.
[Drawing 2] The mimetic diagram showing the shaping approach of the thick lens of the heart thickness by the 2nd invention
(a) The cooling phase of the melting glass drop on female mold
(b) The press-forming phase by the punch.
[Drawing 3] The mimetic diagram showing the shaping approach of the thick lens of the heart thickness by the 3rd invention
(a) The cooling phase of the melting glass drop in the part with the small path of a dies body which it is on female mold
(b) The press-forming phase by the punch.
[Drawing 4] The mimetic diagram showing one example of the melting glass drop manufacture approach.
[Description of Notations]
A punch, 2:female mold, 3:dies body, the melting glass drop under 4:annealing, 5 : 1: The lens by which pressing is being carried out, 6 : The original outer-diameter part used for shaping of a dies body, a part with the small outer diameter of 7:dies body, 8: Penetration pore, 12 which were prepared in the glass drop extruded from the nozzle for melting glass drop dropping, and 9:nozzle, the member (melting glass drop weight control-section material) which prepared 10:penetration pore, and 11:melting glass drop weight control-section material: Melting glass drop.

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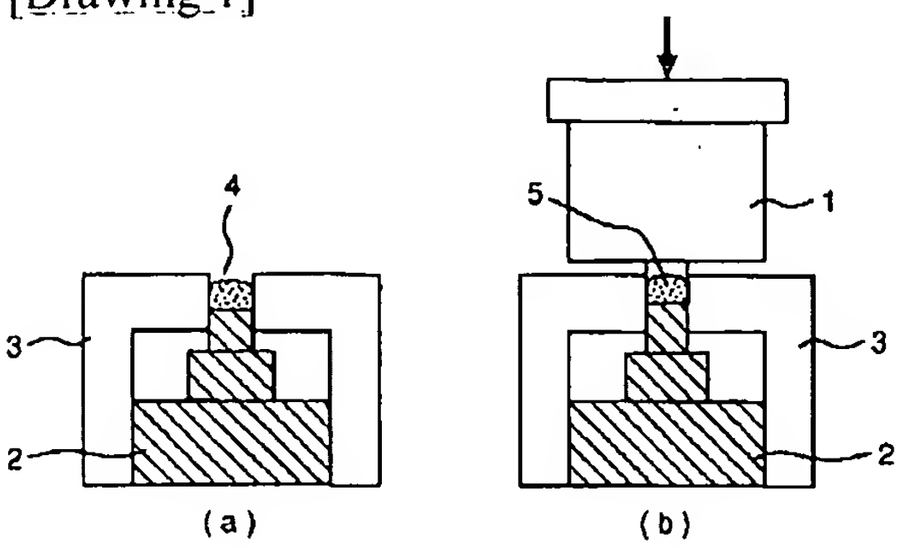
DRAWINGS

[Drawing 1]



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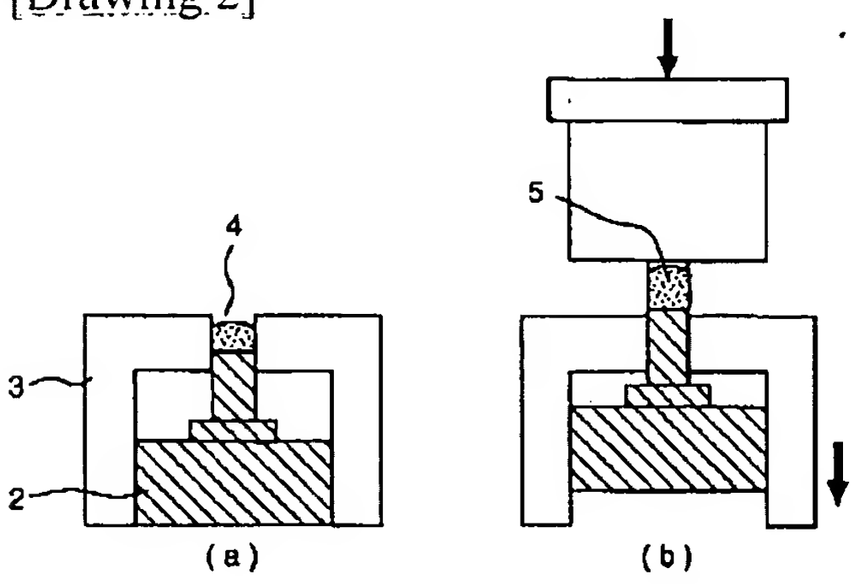
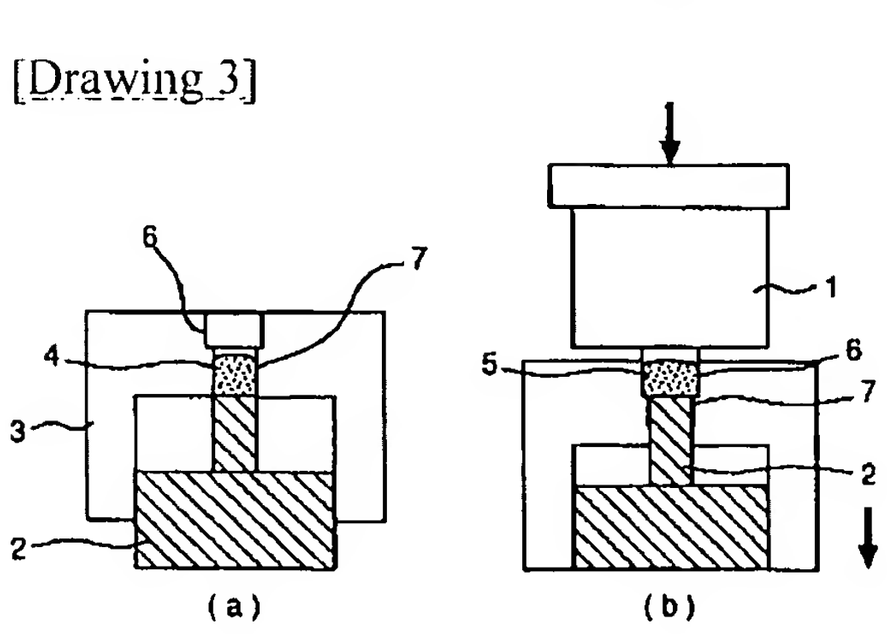
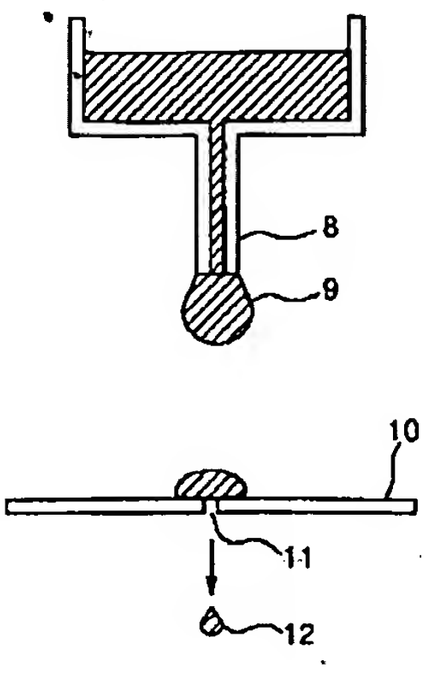


[Drawing 3]



[Drawing 4]



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